ESO # 1147

Factors Associated With the Importance Placed on Environmental Concern in the Adoption of Farm Technologies and Techniques[1]

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Paper presented at the 1985 Southern Association of Agricultural Scientists meeting, Biloxi, Mississippi. February.

Abstract

Data were collected in 1982 from 918 farmers living in nine counties in Ohio to identify the factors that are predictive of attitudes toward environmental concern used in adoption decisions about farm technologies and techniques. A composite scale was constructed from four items which assessed the relative importance of several environmental issues in the adoption decision-making process. Personal characteristics, farm structure variables and selected sources of information were used as predictive variables. The regression findings for conservation concern revealed that two variables were significant in reducing the unexplained variance in the dependent variable. The significant variables were "risk-bearing orientation" associated with the adoption of the farm technology and techniques and "acres farmed". The two variable model explained 26.5 percent of the variance in the environmental concern scores. The findings are discussed in the context of action programs to reduce environmental degradation.

Introduction

Considerable research has been conducted in recent years to identify the factors that are predictive of the adoption of conservation oriented technologies and techniques. Syntheses of these studies indicate that attitudes are very important elements in the decision-making process about adoption (12, 33, 35). The existing literature suggests that farmers must place high value on environmental preservation or they will not consider adopting new technologies or techniques which will reduce environmental degradation. This suggests that research focused on the importance of environmental issues in the decision-making process may provide insight to why farmers choose to adopt or reject conservation-oriented technologies and techniques. Therefore, the purpose of this paper is to present the findings of a study designed to build a model to explain why some farmers place considerable importance on environmental issues when engaged in decision-making about the adoption of new farm technologies and techniques while others do not. The objective of the study was accomplished by building a predictive model from data collected in Ohio using selected aspects of the farm structure literature and elements of the diffusion-social learning models to guide the investigation. The findings of the study are discussed in the context of programs to bring about the adoption of conservation-oriented farm technologies and techniques.

Agricultural Degradation of the Environment

Modern agricultural practices and complex forms of farm technologies have tremendously increased the productivity of U.S. agriculture since the 1930s but at a significant cost to the physical environment. Miranowski (34), for example, has observed that contemporary farming activities have produced externalities in the form of soil erosion, water pollution, declining fertility of land resources and the elimination of existing wildlife species due to habitat destruction. Easter, et al. (15) identified related problems when they observed that some agricultural practices reduce the qualitative aspects of water supplies for other users. In essence, these authors argue that there are both on-site and off-site costs attached to agricultural pollution.

On-site costs, such as the loss of agricultural production capacities due to soil erosion, impact masses of people living in this society and abroad because they depend on U.S. agricultural products for survival. Substantial reduction in our capacity to produce food and fiber would mean loss of income at the farm level, increases in food costs nationally, expanded balance of payments problems internationally and increased hunger in many societies of the world (35).

While it is obvious that our well-being as a society is linked to intelligent use of our soil resources, we continue to employ agricultural practices that contribute to erosion (21, 34). One consequence of this disregard for the physical environment is the fact that 23.5 percent of the nation's farm land is being eroded at more than five tons per acre (26). Such levels of erosion mean that nearly one-fourth of this nation's farm acreage will lose at least one inch of topsoil every 30 years (39). Elfring (16) reports that the average soil erosion rate on all U.S. cropland is seven tons per acre which means that many acres of our farm land are being eroded at very high rates. These data reveal that our future agricultural production capacities are being eroded from the land and deposited along streams, in lakes and in oceans.

The off-site costs associated with agricultural pollution also affect many people within this society but in different ways than on-site costs. Sedimentation of streams and lakes affects every citizen when public resources are required to remove the soil deposits. Removal of agricultural chemicals from drinking water must be internalized by consumers. The loss of water-based recreation opportunity due to unsafe water is a cost for the recreating public. Costs associated with government programs to reduce soil erosion should be included in the assessment of costs of agricultural pollution because they would not exist without the pollution problems. Even subsurface water supplies are not immune from agricultural pollutants. Improper application of agricultural chemicals can contaminate subsurface water supplies which is particularly problematic because we do not have cost-effective means of reclaiming such resources (11, 12, 36).

Another adverse consequence of contemporary agricultural practices is the reduction in the number and variety of wildlife due to the elimination of habitat (34). Conversion of wetlands to agricultural production necessitates drainage which reduces waterfowl nesting and feeding areas. Elimination of fence rows and wind-breaks to facilitate the use of large-scale machinery, combined with fall plowing, effectively reduces cover for many animal species. The ultimate consequence of these practices is the loss of recreation opportunities, reduction in the aesthetic value of land and water, and the slow eradication of animal species which do not have commercial value.

Farmers cannot claim ignorance of the environmental consequences associated with large-scale, agricultural production, because the factors which exacerbate agriculturally-enduced problems have been repeatedly identified and many programs have been implemented to inform landowners of corrective action. Variables such as the use of complex farm technologies, extensive acreage under cultivation, excessive use of farm chemicals, monoculture and row-cropping contribute to environmental degradation (45). This conservation knowledge base has not been totally ignored, however, because there are many farmers who have adopted conservation practices (17, 18, 19, 31, 35, 37, 44) and have recognized the potential environmental problems associated with large-scale agricultural systems (5, 23). Unfortunately, there are many forces in operation which serve to encourage the maintenance of present farm practices but the primary factor is probably economic survival at the farm level (32).

Christensen and Norris (12), Napier and Forster (35) and Miller (32) suggest that the desire for profit is one of the primary determinants of the adoption of conservation-oriented farm practices and technologies. The logic advanced in their arguments is that farmers are subject to many pressures to generate maximum output with the least input. Large-scale agricultural systems tend to accomplish this objective function, while conservation practices and technologies tend to return few profits at least in the short-run. Many farmers simply cannot afford to adopt, if they cannot expect to receive rapid return on their investment. This has been especially true during the past few years when the economic returns to agriculture have been relatively low (13).

In summary, the information provided above strongly suggests that environmental degradation associated with agriculture adversely affects many people in this society and abroad. The information also suggests that farmers are influenced by a multitude of factors in the decision-making process concerning the adoption of farm technologies and techniques. While farmers may be strongly committed to stewardship of the land, they must survive in a competitive market system and may perceive that they are unable to act on their desires to protect the environment (35). This is unfortunate since some farming practices that are highly productive are also environmentally sound (16). Adoption of these types of practices and appropriate technologies to implement them would accomplish the dual objective of producing large quantities of food and fiber while protecting our vital natural resources.

Factors Affecting Conservation Concern and Adoption Behavior

While the objective of the study being reported in this paper was to determine the explanatory factors associated with the relative importance of environmental concerns in the decision-making process about the adoption of new farming technologies and techniques, research could not be located which treated this variable as dependent. To identify potential explanatory variables, the literature devoted to the adoption of conservation practices was examined because it was reasoned that the factors shown to be predictive of actual adoption behavior should be similar to those that facilitate the development of attitudinal propensities to act. Therefore, adoption research focused on conservation practices is discussed below.

Much of the literature focused on the identification of factors associated with environmental concern and the adoption of conservation-oriented technologies and techniques tends to indicate that the predictive variables can be classified into basically four broad categories. The categories are as follows: present farm structure factors, past farm structure variables, personal characteristics and access to various types of information systems.

In the context of present and past farm structure variables, research by Buttel, et al. (7) revealed that attitudes about the environment were significantly related in an inverse manner with farm size. Farmers with larger numbers of acres tended to be less concerned about the environment. Miranowski (33), however, observed that operators of larger farms tended to adopt more conservation oriented practices than people farming smaller acreage. Research by Napier, et al. (37) revealed that farm size was not significantly related to adoption of soil erosion control practices but that indicators of the complexity of the farm operation were inversely related with the adoption of conservation tillage practices. The best explanatory variables were present technologies used, type of farm products emphasized in production, agricultural education and access to information. As the complexity of the farm operation increased there was a decrease in the use of conservation tillage practices. These studies suggest that farm structure measures may affect conservation attitudes among farmers.

Risk-bearing orientation is closely related to farm structure variables because the economic viability of the farm enterprise is directly related to decisions made about farming practices and technologies used in the past. Economically viable farmers may be able to assume some risks to protect the environment while economically stressed farmers cannot. Risk is important in the study being reported here because it has been shown to influence adoption of conservation practices and farming technologies (33). If farmers do not believe that they will receive benefits from investing in conservation techniques and technologies, then they will not adopt. For example, C. Ervin (17) and Ervin and Alexander (18) discovered that farmers in Missouri were motivated to adopt new practices, if they believed that they would profit from the investment. Research conducted in Ohio (19), Kentucky (43) and Idaho (10) arrived at similar conclusions. Thus, perceptions of risk appear to be associated with the adoption of conservation practices and technologies.

Access to information has been advanced as being one of the most important predictive factors associated with adoption behavior (1, 29, 38, 40, 41, 42, 44). Proponents of the diffusion perspective argue that once farmers are informed of the advantages of using specific technologies and practices they will adopt the innovations. Research by Hassan (22) and by Camboni (8), however, suggest the broad assertions made by diffusionists are incorrect. These researchers observed that access to information systems was not related to adoption of farm machinery (8) nor to evaluation criteria (22). Napier, et al. (37) and Miranowski (33) suggest that education is probably related to adoption of certain types of conservation practices but it is only one of many factors to be considered. Even with the concerns expressed about the model, diffusionists argue that access to information systems is the most influential factor in the adoption of new farm technologies and techniques.

Other learning-type variables which have been shown to be related to adoption behavior are age and farming experience (40, 41, 42). This literature advances the position that older farmers are more risk-averse and are, therefore, less likely to adopt new practices and techniques. Research by Miranowski (33) and Ervin (17) tend to support the research tradition while findings produced by Napier, et al. (37) demonstrated that age and years of farming tended to be inconsequential in explaining adoption of soil conservation practices.

In sum, the research focused on adoption of conservation practices and technologies suggests that farm structure factors, access to information systems, risk-bearing orientation and personal experience measures are related to adoption behavior. Consequently, a theoretical model which integrated these factors was used to guide the investigation. The theoretical perspective was termed the social learning-diffusion model (8, 9, 22).

Research Expectations

Given the types of variables which were shown to be significantly related with the adoption of conservation practices, an eclectic theoretical perspective based on the diffusion model (4, 40, 41, 42) and arguments advanced in the farm structure literature (6, 20, 24, 37, 46) was constructed and used to guide the investigation. The basic arguments of the eclectic perspective are outlined below.

The Diffusion Model

The diffusion model basically asserts that propensities to enact behavior are products of learning experiences. The model argues that access to information sources is the primary determinant of adoption behavior because it is assumed that when people are made aware of the advantages of adopting a specific technology or technique they will develop a positive attitude toward the object being assessed and will ultimately adopt the new practices or technologies which they believe will produce rewards for them. Mass media systems, personal contact with knowledgeable people, formal education and personal experiences are some of the types of mechanisms individuals can use to access information about new technologies, ideas and practices.

The diffusion model posits that individuals who have greater exposure to learning mechanisms will have the greatest probability of adopting new practices because they will possess the most information for decision-making and will have developed the most positive attitudes toward the objects being evaluated. If the advantages of any new practice are demonstrated to outweigh the disadvantages, it is assumed that the person receiving the knowledge will evaluate the merits of the technique or technology being assessed favorably and adopt.

If farmers are to be concerned about the environment, they must be made aware of the problem. While concern for the environment has been articulated by enlightened individuals for many years (30), national programs to inform the public of environmental problems associated with large-scale agriculture are relatively short-lived. Mass media systems, state and federal agencies, educational units and other mechanisms for providing information have initiated programs to influence farmers to be environmentally concerned and to exhibit these orientations in the form of adoption of conservation-oriented practices. If the diffusion model is correct, then measures of access to institutional information systems, contact with interpersonal sources of information, formal educational experiences, personal farming experiences and age will be significantly related to the importance placed on environmental concerns. Therefore, it is hypothesized that diffusion-type variables will be significantly related to the importance placed on environmental concerns used in adoption decision-making about new farming technologies and techniques.

The Farm Structure Model

One of the major criticisms of the diffusion model is the relative lack of concern for <u>ability to act</u> factors. While the diffusion model recognizes that economic variables play a role in the adoption process, it relegates such variables to a lesser position in the decision-making process than other models. A recently emerging perspective for examining behavior of farmers is the farm structure model which asserts that farmers must have the ability to enact their desires or they will not adopt new practices.

The farm structure model basically argues that farmers cannot adopt new technologies and techniques, if they do not have the economic resources to invest no matter how much they may wish to do so. The model also asserts that past investments in technologies and techniques strongly influence future adoption decisions because technologies presently in use cannot be retired until initial investments have been adequately recovered. Synergism is a relevant concept to the discussion because farm technologies and techniques must be compatible, if scale efficiencies are to be achieved. Farmers own and use technologies and techniques that are complementary which further reduces their freedom to change to different farming methods even if they wished to try new methods. In essence, the model asserts that farm structure factors such as farm size, type of products produced on the farm, present and past technologies employed and other farm characteristics are the most important determinants of what types of farming technologies and techniques will be adopted and the criteria that will be used in the decision-making process.

In essence, the farm structure model suggests that farmers of large-scale operations will have the fewest degrees of freedom in decision-making because the amount of investment made in technologies in the past precludes significant changes in farm techniques and technologies to implement them. While large-scale farmers may have the economic resources to adopt, many of their future farming decisions have been made in the past which suggests that they actually have relatively few options. Such farmers will continue to do what they have done in the past. Unless the conservation technologies and techniques are compatible with on-going practices, they will probably not be adopted. Large-scale farm operators usually emphasize profit maximization and farm practices which tend to accomplish such objective functions but these techniques often have adverse consequences for the environment. This line of reasoning suggests that measures of large-scale farming operations will be inversely related to the importance placed on environmental concerns in the decision-making process about future adoption of farm tecnhnologies and techniques. Therefore, it is hypothesized that farm structure indicators will be significantly related to the importance placed on environmental concerns in the decision-making about the adoption of new technologies and techniques.

Path Diagram

The factors included in the study were used to build an interactive path model to examine the relationships between each independent variable and environmental concern as well as the relationships among the independent variables. Logical time ordering of the variables made it possible to predict causal ordering. The expected path model is presented in Figure 1.

(Figure 1 Here)

Figure 1 basically asserts that past farm structure variables and personal characteristics occur prior to the emergence of any of the other variables included in the model and contribute to the explanation of the variables which follow. No causal relationships are stated between personal characteristics and past farm structure measures. Personal characteristics, past farm structure factors and present farm structure measures are posited to explain use of both types of information systems. All of these variables are expected to operate indirectly through risk-bearing orientation to the dependent variable. All of the predictive variables are expected to be significantly related to environmental concern.

Methodology

Sample Selection

Data to examine the merits of the research expectations discussed above were collected in the spring and summer of 1982 from a sample of Ohio farmers living in nine counties chosen at random from the extension districts in the state. A sample of 918 farmers was selected using a systematic, random sample approach (3) from within the study counties. Personal interviews were conducted using trained, local volunteers for data collection purposes. Only individuals with gross farm incomes of $1,000 or more were included in the sample, which means that small-scale farming operations were effectively excluded from the study. The findings must be evaluated in the context of this sampling limitation.

The interviewers were assigned a specific geographic area from which a designated number of study respondents were to be drawn. The interviewers were instructed to select every tenth occupied farmstead along rural roads and to ask the head-of-household or mate to participate in the study. Over 95 percent of the people asked to participate actually consented to complete a questionnaire.

The characteristics of the study respondents were compared with agricultural census information for 1982 to assess the similarity of the sample data with known characteristics of Ohio farmers as a group. These data are presented in Table 1 and show that the sample and the state-wide data are very comparable. The only variable which differs to any appreciable degree is percent of off-farm employment. This difference is probably due to nonresponse from part-time farmers who are primarily engaged in off-farm employment. Such people would be less inclined to respond to the questionnaire since it requested a great deal of information about their farm operation which they would find irrelevant to their situation. Given the high response rate, large sample size, wide geographic distribution of the sample and the similarity of the sample data with known characteristics of farmers in the state, it is argued the data are adequate to evaluate the research expectations as they are outlined above.

(Table 1 here)

A structured questionnaire was used for data collection to reduce error associated with an open-ended type of interview, such as the use of leading statements and the lack of standardization of questions asked. The interviewers received instruction in the use of the questionnaire, sample selection techniques, interviewing techniques and the manner in which the responses were to be recorded. Each question was read to the respondent and the interviewer recorded the responses on the questionnaire. The content of the questions included in the questionnaire was derived from theoretical concepts, previous research studies, existing literature focused on the sociology of agriculture and practical experiences of the researchers. Initial drafts of the questionnaire were shared with knowlegeable professionals in the College of Agriculture at the Ohio State University and revisions were made in the content consistent with suggestions from consulting colleagues.

Variable Selection and
Operationalization

The dependent variable selected for examination was termed "environmental concern scale." The variable was measured by asking the respondents to evaluate the relative importance of several factors in the decision-making process about the adoption of farm technologies and techniques to be used in their farming operations. The respondents were asked to note how important were the perceived impacts of the adoption of new technologies and techniques on water pollution, soil erosion, long-term land fertility and wildlife in the decision-making process. The possible responses ranged from "not important" to "very important." Nine possible responses were provided to the study participants and the responses were weighted 0 to 8 with 0 representing "not important" and 8 representing "very important." Item analysis was conducted on the responses to the four scale items and an alpha of .86 was produced. An alpha of this magnitude is defined as being <u>very</u> good and demonstrates that the responses can be legitimately combined because the items are highly intercorrelated. The responses to the four items were summed to form a composite measure of the importance attached to environmental concerns in the decision-making process associated with the adoption of farm technologies and techniques.

The 16 independent variables selected as predictive variables were chosen on the basis of the literature focused on adoption of conservation practices and the theoretical modeling. The variables used to represent the social learning component of the theoretical perspective were as follows: use of institutional and noninstitutional sources of information, age, agricultural education experiences and years farming. The variables selected to represent the farm structure elements of the model were as follows: present farm structure variables (percent grain farmer, percent livestock farmer, percent other farmer, farming status of farmer and mate, and acres farmed); past farm structure variables (parent's farming status, acreage farmed by parents, tractor size used 10 years ago and combine bin capacity 10 years ago); and risk orientation. Each of these variables was measured in the following manner:

<u>Institutional sources of information</u> was measured by asking the respondents to note how frequently various sources of agricultural

information were used. There were eight response categories which ranged from "daily" to "never" with 0 representing the "never" category and 7 representing the "daily" category. The types of institutional sources of information assessed were as follows: the state agricultural experiment station, local farmer organizations, the county extension agent, Ohio State University staff and the Ohio Cooperative Extension Service. Item analysis was conducted on the responses to these variables and an alpha coefficient of .81 was produced which is defined as being very good.

Noninstitutional sources of information was evaluated by asking the respondents to indicate how frequently they used various interpersonal sources of agricultural information. The same weighting and response procedures discussed in the previous variable were used for this factor as well. The sources examined were as follows: friends, neighbors and local merchants. Item analysis of the intercorrelations produced an alpha coefficient of .81 which indicates that the responses can be legitimately combined into a composite measure.

Age was measured as the age of the principal farm operator at last birthdate.

Agricultural education was assessed by asking the respondents to note the types of educational experiences in agriculture attained by the principal farm operator. The number of agricultural experiences reported was summed.

Years farming was measured by asking the respondents to indicate the number of years the principal farm operator had been farming.

Percent grain farmer was assessed by asking the respondents to indicate the percent of gross farm income derived from grain crops (corn, soybeans and wheat) during the last three years.

Percent livestock farmer was evaluated in the context of the percent of gross farm income derived from livestock (beef, dairy, swine, poultry and sheep) during the last three years.

Percent other farmer was assessed by asking the respondents to note the percent of gross farm income derived from vegetables, fruits, hay and other crops during the last three years.

Farming status was assessed by asking the respondents if the principal farm operator had worked more than 100 days off the farm during the preceding year. A "yes" response received a value of 1, while a "no" response received a 0.

Farming status of spouse was measured by asking the respondent if the mate of the principal farm operator had been employed more than 100 days off-the-farm during the previous year. A "yes" response received a value of 1, while a "no" response received a value of 0.

Acres farmed was measured as the number of acres usually farmed each year by the principal farm operator.

Parents' farming status was measured by asking the respondents to indicate if the parents of the principal farm operator were engaged in farming. A "yes" response received a value of 1, while a "no" response received a 0.

Acres parents farmed was measured by asking the number of acres the parents of the principal farm operator farmed.

Tractor size 10 years ago was evaluated in terms of the horsepower of the largest tractor in use on the farm 10 years ago.

Combine bin size 10 years ago was measured in terms of the bin capacity in bushels of the largest combine in use 10 years ago.

Risk-bearing orientation was measured by asking the respondents to indicate how much importance they placed on how risky the adoption of new farm technologies and techniques is to the farm operation in the decision-making process. There were nine possible response categories with 0 representing "not important" and 8 representing "very important."

Statistical Analysis

Regression analysis was used to build an interactive path model which specifies the relationships between the independent variables and the environmental concern scale as well as the relationships among the independent variables. Linear relationships were assumed to exist among the variables and the attitude items were assumed to produce metric measure (2, 25, 28). Missing data were assigned the mean value of the variable and the cases were salvaged for analysis purposes. This approach has been shown to be the best method for addressing the problem of missing data when the sample is large and the correlations are low to moderate (14). The amount of missing data was also relatively small which is additional evidence that the mean substitution approach was appropriate.

Findings and Discussion

Correlation Findings

The bivariate correlations between the independent variables and the environmental concern scale are presented in Table 2. These findings reveal that three variables were significantly correlated with the dependent variable at the .05 level. The three significant variables were institutional sources of information, tractor size 10 years ago and risk-bearing orientation. Institutional sources of information and risk-bearing orientation were shown to be positively related to the dependent variable, while tractor size was inversely related. The correlation for risk-bearing orientation and the environmental concern scale was moderate, while the other two significant correlations were very low. The correlation findings revealed the following: 1) farmers who used more numerous institutional sources of information on a more frequent basis tended to be more concerned about environmental issues in the decision-making process; 2) farmers who were more concerned about the risks attached to adopting new technologies and techniques on the farm level tended to be more concerned about environmental concerns; and 3) farmers who used smaller tractors on their respective farms 10 years ago tended to be more concerned about environmental issues when making future adoption decisions.

(Table 2 Here)

Regression Findings

Regression analyses were used to determine the relative explanatory power of the independent variables when all variables were considered simultaneously and to build an interactive path model to specify the relationships among the study variables. The first analysis consisted of regressing the variance in the environmental concern scale against the independent variables included in the model. These findings revealed that two variables were significant in reducing the unexplained variance in the dependent variable. The two significant variables were risk-bearing orientation and number of acres usually farmed. The two-variable model explained 26.5 percent of the variance in the dependent variable. The regression equation is presented in standardized regression coefficient form (beta) as follows:

$$Y = 0.513x1 - 0.072x2$$

where: Y= environmental concern scale

x1= risk-bearing orientation

x2= number of acres farmed

coefficient of determination= 0.265.

The regression findings revealed that the best explanatory factor was the farmer's risk-bearing orientation. This variable alone explained 25.3 percent of the variance in the dependent variable. As the relative importance of risk increased, there was a concomitant increase in the perceived importance of environmental issues in the decision-making process. Farmers in the sample who tended to be more concerned about the risks to the farming enterprise from adopting new farm technologies and techniques also perceived environmental concerns as being more important considerations in the decision-making process.

This finding was very surprising since it was expected that risk orientations would serve to reduce the priority attached to environmental considerations in the decision-making process because adoption of conservation techniques and technologies to implement them seldom result in significant economic returns to investment. Without careful evaluation of the study findings, one would be lead to conclude that risk-averse farmers will be the most receptive group to adopting conservation programs, since they tend to be more inclined to consider environmental issues in their decision-making. It is quite possible, however, that risk-averse farmers will be very reluctant to adopt conservation practices because they will probably be risk-averse to all innovations including conservation practices. While they will undoubtedly consider environmental issues in the adoption process, they will probably place more emphasis on technologies and techniques which have been shown to be profitable in the past because they do not wish to assume risk of adopting practices which will place their farm operations in jeopardy. Many of the farm practices which have been shown to be the most profitable in the short-run also often contribute to environmental degradation.

It is also quite possible that risk-averse farmers consider a greater number of issues including potential degradation of the physical environment than do other types of farm operators when engaged in decision-making. Farmers who are less concerned about the risks attached to the adoption of new techniques and technologies on the viability of the farming enterprise probably use more narrowly defined criteria which would place higher priority on other decision-making factors such as profit maximization. Farmers who are not concerned very much about the impacts of adoption on the farming operation probably consider few options other than the practices and technologies which they have discovered to be relevant and profitable in the past. These types of farmers would tend to place higher priority on past performance in assessing farming practices and technologies rather than the potential impacts on the environment.

The regression findings also demonstrate that the number of acres farmed was significant in reducing the unexplained variance in the dependent variable. The addition of this variable increased the explained variance 1.2 percent. As the number of acres usually farmed increased, there was a slight decrease in the perceived importance of conservation issues in the decision-making process about the adoption of farm technologies and techniques. This finding indicates that operators of larger farming operations tend to be slightly less concerned about environmental issues than are individuals who farm fewer acres. Since farming large acreage necessitates certain types of farm technologies and techniques to achieve economies of scale efficiencies, such farmers will be pressured by personal aspirations, past investment in technologies, capital flow problems and numerous other factors to be as efficient as possible. Subsequently, environmental concerns would tend to be relegated to a lesser priority position in the decision-making process.

Interactive Path
Analysis Findings

The theoretical perspective presented in diagrammatic form in Figure 1 was evaluated in the context of the data provided by the study respondents. The purpose of the analyses was to determine the relative importance of indirect affects on the dependent variable by antecedent factors that were not directly related. The revised model which includes only significant relationships is presented in Figure 2.

(Figure 2 Here)

The revised path model reveals that past and present farm structure variables, personal characteristics, and various information sources have relatively little indirect affect on environmental concern. While the revised model basically supports the general pattern of relationships specified in Figure 1, the explained variance for risk-bearing orientation and access to institutional sources of information is very low (1.6 percent and 3.7 percent respectively). The path analysis findings indicate that variables other than risk-bearing orientation and acres usually farmed included in the analysis are of no consequence in understanding attitudes toward the importance of environmental concern in the decision-making about the adoption of farm technologies and techniques. These findings strongly suggest that future theoretical modeling focused on the phenomenon under study should proceed along the lines of risk orientation because nearly all farm structure indicators (both past and present) and all personal characteristics were shown to have no direct affect on the dependent variable under study and to have miniscule indirect affects through designated intervening variables.

One of the most important findings from an applied perspective is the lack of predictive ability of institutional and noninstitutional sources of information. Inspection of the path model (Figure 2) reveals that access to noninstitutional sources of information is not directly nor indirectly linked with the dependent variable. Institutional sources of information is linked indirectly in a very weak manner with the environmental concern index. This is very surprising since a common approach for bringing about the adoption of farm techniques and technologies is the combined use of these mechanisms for diffusing information. These findings suggest that use of traditional mechanisms for diffusing information will have little influence on the relative importance placed on environmental concerns in the decision-making process about the adoption of farm technologies and techniques at the farm level.

The regression equations used to build the revised interactive path model are presented in Table 3. All of the coefficients included in the table are significant at the .05 level.

(Table 3 Here)

Conclusions

The research findings basically demonstrated that the theoretical perspective used to direct this study was relatively ineffective in predicting the importance placed on environmental concerns in the decision-making process about the adoption of farm technologies and techniques. While two variables were shown to be significant in reducing the unexplained variance in the dependent variable, one factor accounted for practically all of the explained variance. The best predictive variable was risk-bearing orientation.

The study findings demonstrated that farmers who were more risk-averse tended to be more concerned about environmental issues when they were engaged in the adoption decision-making process. The study findings have tremendous implications for action programs to increase the adoption of conservation techniques and technologies but the implications are not very encouraging for pro-environmental interests. Unfortunately, the segment of farmers who have the highest propensity to consider environmental concerns in the adoption decision-making process are also the group of farmers who have the highest aversion to risk. Such findings suggest that change agents will have a difficult time motivating even those farmers who are sympathetic to environmental issues since they will probably be reluctant to adopt any new farming technique and technology.

The study findings imply that awareness programs will be relatively inconsequential in bringing about adoption of conservation techniques and technologies. Farmers who are concerned about the environment must be convinced that adoption will not result in higher risks to continued viability of the farm or they will probably not adopt. Simply making people aware of enviromental problems will not bring about adoption. Empirical research to demonstrate that the use of conservation practices can be profitable without introducing more uncertainty into the adoptors' lives will be required. Awareness programs may be useful for alerting less sensitive farmers to the potential negative consequences of ignoring environmental problems associated with agriculture. It is highly probable, however, that these types of farmers will be reluctant to embrace an environmental ethic because such an orientation would require modification of existing practices. Action programs should be "targeted" to particular client groups with considerable attention focused on those farmers who are concerned but the content of the programs should be information to reduce perceptions of risk attached to adoption rather than awareness of the problems.

Footnotes

1. Salaries and research support provided by federal and state funds appropriated to the Ohio Agricultural Research and Development Center and the Ohio State University via the State 502 project and Hatch 722. The authors wish to recognize several contributors to the research project. The Nationwide Insurance Company, the National Institute for Farm Safety and the Samuel Frantz family made economic contributions to the project. Ohio Cooperative Extension Service staff participated in the study during the data collection phase of the project. Special recognition is given to Lyndal K. Napier for secretarial support during the writing phase of the study. This manuscript is a revised version of a paper presented at the 1985 Southern Association of Agricultural Scientists meeting in Biloxi, Mississippi.

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Table 1: Summary Characteristics of Study Sample (N=918) Compared with the 1982 Census of Agriculture for Ohio (N=86,942)[a]

Characteristic	Sample (1982)	Census of agriculture[b] (1982)
Age of farmer (%)	<35 = 17.9	<35 = 17.5
	35-44 = 23.0	35-44 = 20.5
	45-54 = 24.9	45-54 = 22.0
	55-64 = 22.7	55-64 = 23.2
	>65 = 10.2	>65 = 16.7
	no data = 1.3	not applicable
	$\bar{x}$ = 47.8 years	$\bar{x}$ = 49.8
Years of farming	$\bar{x}$ = 26.8 years	not available
Farm size by acres owned (%)	1-49 = 27.7	1-49 = 28.7
	50-179 = 35.5	50-179 = 41.4
	180-499 = 27.6	180-499 = 22.4
	500-999 = 5.9	500-999 = 5.9
	1,000-1,999 = 1.0	1,000-1,999 = 1.5
	>2,000 = 0.1	>2,000 = 0.1
	no data = 2.2	not applicable
	$\bar{x}$ =175.9 acres	$\bar{x}$ =177.0
Tractor ownership	$\bar{x}$ = 3.3 tractors	$\bar{x}$ = 2.2
Combine ownership	$\bar{x}$ = 0.9	$\bar{x}$ = 0.4
Source of agricultural income for past 3 years	crops = 50.8	crops = 55.0[c]
	livestock/other= 39.7	livestock/ other = 45.0[c]
	no data = 9.5	not applicable
Percent of farmers employed 100 days or more off the farm	33.1	49.3

Figure 1: Expected Interactive Path Model Deduced From the Social Learning-Farm Structure Model to Predict Environmental Concern Associated With Adoption Decision-Making

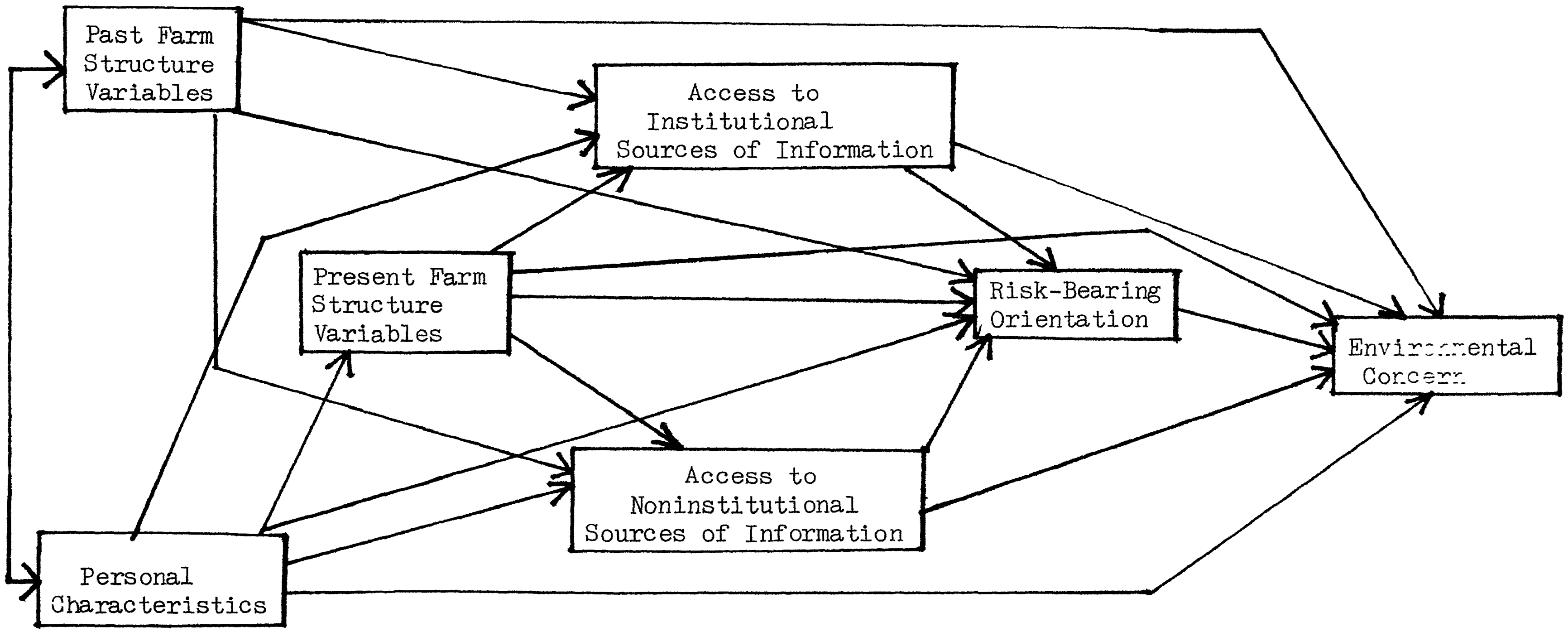

Table 2: Bivariate Correlation Coefficients Between Environmental Concern Scale Scores and Selected Independent Variables (N=918)

Independent Variable	Correlation Coefficient
Institutional sources of information	0.08*
Noninstitutional sources of information	0.02
Age	0.01
Agricultural education	0.01
Years farming	- 0.03
Percent grain farmer	- 0.05
Percent livestock farmer	- 0.04
Percent other farmer	0.02
Farming status of operator	0.05
Farming status of spouse	0.05
Acres farmed	- 0.06
Parents' farming status	- 0.01
Acres parents' farmed	0.00
Tractor size 10 years ago	- 0.08*
Bin capacity 10 years ago	- 0.02
Risk-bearing orientation	0.50*

* Significant at the .05 level using a two-tailed test.

Figure 2: Actual Interactive Path Model Formulated From Data Provided by Respondents (N = 918)

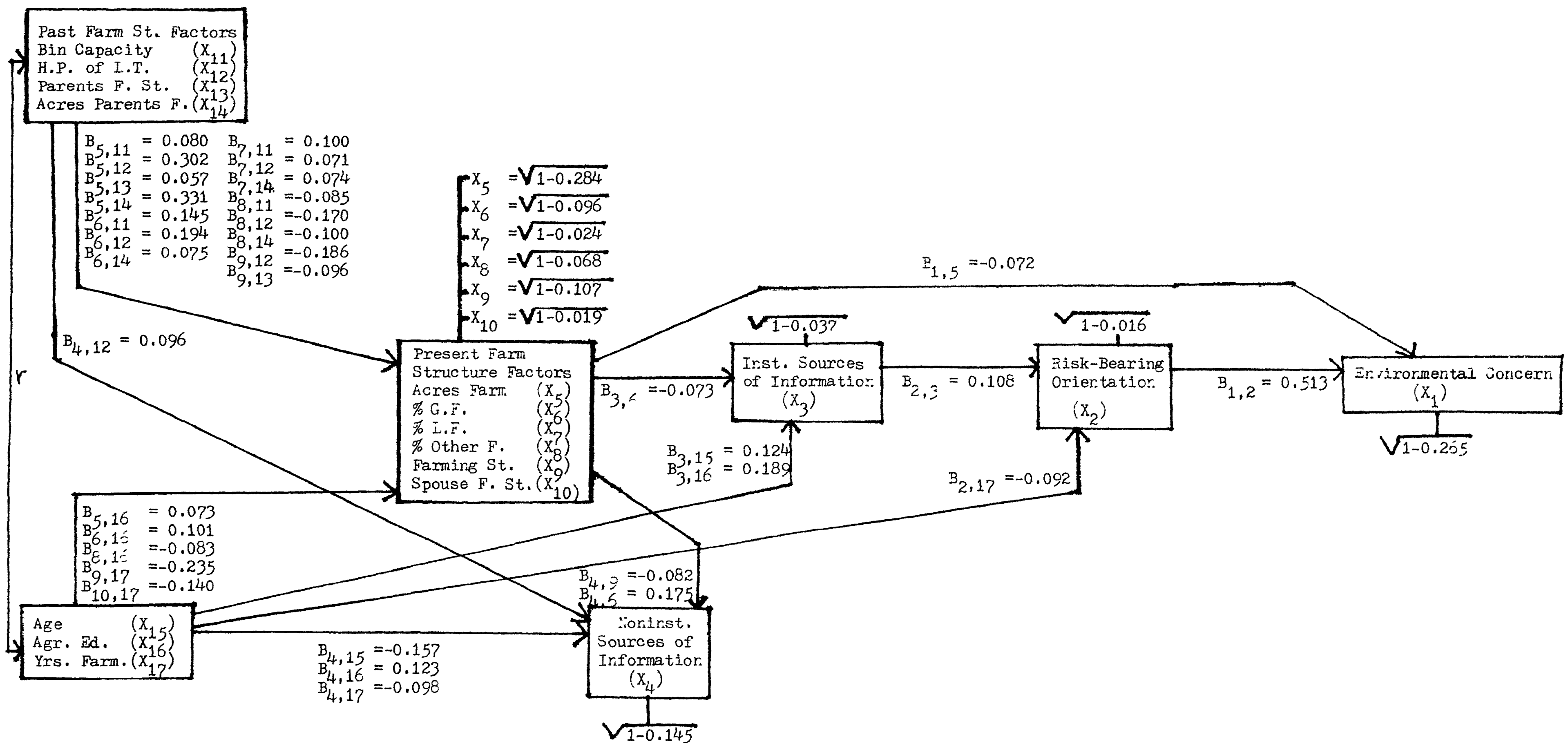

Table 3: Equations for the Significant Relationships Among the Variables Included in the Interactive Path Model for Environmental Concern (N=918)

Dependent Variable	Equation	Coefficient of Determination
Environmental concern (x1)	Y= 0.513x2 - 0.072x5	0.265
Risk-bearing orientation (x2)	Y= 0.108x3 - 0.092x17	0.016
Institutional sources of information (x3)	Y= -0.073x6 + 0.124x15 + 0.089x16	0.037
Noninstitutional sources of information (x4)	Y= 0.176x6 - 0.082x9 + 0.096x12 -0.157x15 + 0.123x16 -0.098x17	0.145
Acres farmed (x5)	Y= 0.080x11 + 0.302x12 + 0.057x13 +0.331x14 + 0.073x16	0.284
Percent grain farmer (x6)	Y= 0.145x11 + 0.194x12 + 0.075x14 +0.101x16	0.096
Percent livestock farmer (x7)	Y= -0.100x11 - 0.071x12 - 0.074x14	0.024
Percent other farmer (x8)	Y= -0.085x11 -0.170x12 - 0.100x14 -0.083x16	0.068
Farming status of operator (x9)	Y= -0.186x12 - 0.096x13 - 0.235x17	0.107
Spouse farming status (x10)	Y= -0.140x17	0.019

X1= Environmental concern scale scores
X2= Risk-bearing orientation
X3= Institutional sources of information
X4= Noninstitutional sources of information
X5= Acres farmed
X6= Percent grain farmer
X7= Percent livestock farmer
X8= Percent other farmer
X9= Farming status of operator
X10= Spouse farming status
X11= Bin capacity 10 years ago
X12= Tractor size 10 years ago
X13= Parents' farming status
X14= Acres parents farmed
X15= Age of farmer
X16= Agricultural education
X17= Years farming

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